IN THE SPECIFICATION

Please amend the paragraph on page 1, lines 4-7, as follows:

This application is related to Application No.[________] 09/770,544, entitled "Mobility Prediction in Wireless, Mobile Access Digital Networks," naming as inventor Youngjune L. Gwon, filed on January 26, 2001, the entire specification of which is incorporated herein by reference for all purposes as if fully set forth herein.

Please amend the paragraph at page 2, lines 13-31, as follows:

The Internet and nearly all digital data networks connected to it today adhere to substantially the same addressing and routing protocols specified in the "network layer" or "layer 3." According to these protocols, each node in the network has a unique address, called the Internet Protocol (IP) address. To communicate digital data over the network or between networks, a sending or source node subdivides the data to be transmitted into "packets." The packets include the data to be transmitted, the IP addresses of the source node and the intended destination node, and other information specified by the protocol. A single communication of data may require multiple packets to be created and transmitted depending on the amount of data being communicated and other well known factors. The source node transmits each packet separately, and the packets are routed via intermediary nodes in the network from the source node to the destination node by a "routing" method specified by the protocol and well known to those skilled in the art. See Internet protocol version 6, specified as Internet Engineering Task Force (IETF) RFC 2460. The packets do not necessarily travel to the destination node via the same route, nor do they necessarily arrive at the same time. This is accounted for by providing each packet with a sequence indicator as part of the packetizing process. The sequence indicators permit the destination node to reconstruct the packets in their original order even if

they arrive in a different order and at different times, thus allowing the original data to be reconstructed from the packets.

Please amend the paragraph, beginning on page 4, line 31 to page 5, line 18 as follows:

Additionally, the current Internet addressing and routing protocols and approaches for fixed node data networks are incapable of supporting the dynamically changing addressing and routing situations that arise in recently proposed wireless, mobile-access digital data networks. The International Telecommunication Union (ITU) of the Internet Society, the recognized authority for worldwide data network standards, has recently published its International Mobile Communications-2000 (IMT-2000) standards. These standards propose so-called third generation (3G) data networks that include extensive mobile access by wireless, mobile node devices including cellular phones, personal digital assistants (PDA's), handheld computers, and the like. (See ~~http://www.itu.int~~ the home page of the International Telecommunication union on the world-wide-web, i.e., www.itu.int). Unlike previous wireless, mobile access, cellular telephony networks, the proposed third generation networks are entirely IP based, i.e., all data is communicated in digital form via standard Internet addressing and routing protocols from end to end. However, unlike current fixed node networks, in the proposed third generation wireless, mobile access networks, wireless mobile nodes are free to move about within the network while remaining connected to the network and engaging in data communications with other fixed or mobile network nodes. Among other things, such networks must therefore provide facilities for dynamic rerouting of data packets between the communicating nodes. The current Internet addressing and routing protocols and schemes, which are based on fixed IP addresses and fixed node relationships, do not provide such facilities.

Please amend the paragraph on page 5, lines 19-28, as follows:

Standards have been proposed to deal with the mobile IP addressing and dynamic routing issues raised in third generation, wireless, mobile access IP networks. For example, the Internet Engineering Task Force (IETF), an international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet, have proposed several standards to deal with IP addressing and dynamic rerouting in much mobile access networks. (See ~~http://www.ietf.org~~ the home page of the IETF on the world-wide-web at www.ietf.org). These include proposed standards for IP Mobility Support such as IETF RFC 2002, also referred to as Mobile IP Version 4, and draft working document "draft-ietf-mobileip-ipv6-12", entitled "Mobility Support in IPv6," also referred to as Mobile IP Version 6.

Please amend the paragraph beginning on page 6, line 26 to page 7, line 9 as follows:

Efforts have been made to address the issues of packet transmission delay in mobile access IP networks due to the mobility of network nodes. One current IETF proposal suggests to extend the proposed Mobile IP standards to optimize the routing of packets by establishing a direct route between a mobile and correspondent node and bypassing the "tunneling" of packets through the mobile node's home "agent" router. (See "draft-ietf-mobileip-optim-09.txt" entitled "Route Optimization in Mobile IP" which may be obtained from the IETF ~~www.ietf.org/internet-drafts~~). This proposal is directed to the well-known asymmetrical latency problems that result from "triangular routing" inherent of packets between mobile nodes and correspondent node under the proposed Mobile IP standards. However, the proposal only addresses steady state latency issues. That is, the direct route for

data communications envisioned by the current proposal is only established after communications between the mobile and correspondent node have been handed off from one neighboring node to another. Thus, the proposal does not address the signficant delays incurred during and immediately following the hand-off process itself, which are perhaps the most critical with respect to real-time interactive data communications like VoIP.

Please amend the paragraph on page 7, lines 10-19, as follows:

Another proposal made by Su and Gerla working at the University of California, at Los Angeles (UCLA) has been to use predictive analyses to determine the direction and location of mobile nodes relative to other mobile nodes in a completely mobile "ad hoc" data network. In this proposal, the velocity and direction of movement of the various mobile nodes is employed to predict the duration of time neighboring nodes can remain in communication before a hand-off must occur. This proposal does not present a suitable solution for the packet delay problems facing third generation mobile access networks for a number of reasons. One reason is that the mathematical calculations involved are so extensive and complex that implementation is not practically possible in modem mobile node devices, which have relatively limited processing and computational facilities.

Please amend the paragraph on page 9, lines 15-17, as follows:

Figure 6 is a graphical representation of the format of a packet routing header, including exemplary routing header 500, according to IETF Mobile IP version 6 for use in routing packets in third generation wireless, mobile access, IP data networks.

Please amend the paragraph on page 12, lines 8-15, as follows:

The present invention is concerned with the macro and intermediate mobility levels wherein a mobile node changes location within the network such that its network link changes from one agent to another. The hand-off operation between agents that results from such macro mobility is specified in IETF RFC 2002 for proposed Mobile IP version 4 and in "draft-ietf-mobileip-ipv6-12.txt" (work in progress) ~~at "www.ietf.org/internet-drafts"~~ for proposed Mobile IP version 6, which may be obtained from the IETF. Figure 2 provides a simplified graphical illustration of the hand-off process in a Mobile IP version 6 network.

Please amend the paragraph, beginning at page 13, line 24 to page 14, line 2, as follows:

Alternatively or additionally, the mobile node (MN) 135 can employ the Neighbor Discovery methodology specified in IETF RFC 2461, which is incorporated herein by reference, and which is recommended for Mobile IP version 6 mobile nodes in the IETF Mobile IP Version 6 draft document (section 10.4) previously identified and incorporated by reference. In particular, the mobile node (MN) 135 should preferably use Neighbor Unreachability Detection as described in RFC 2461 to detect Transport Control Protocol (TCP) acknowledgements of data packets sent to local router RI and/or to receive Neighbor Advertisement messages from local router R1 in response to Neighbor Solicitation messages from other mobile nodes in the area, or unsolicited Router Advertisement messages from local router R1, as indications of a continuing, degrading or lost connection with local router R1.

Please amend the paragraph on page 18, lines 9-18, as follows:

The mobility prediction analysis 710 is preferably carried out in the network layer 3 logical addressing and routing programming of the mobile node 135 or agent 145 and is transparent to the network. The presently preferred embodiments of the mobility prediction process 710 are described in detail in the inventor's co-pending Patent Application No.[______] 09/770,544, entitled Mobility Prediction In Wireless, Mobile Access Digital Networks, filed on January 26, 2001, the entire specification of which is incorporated herein by reference as if set forth in full. The co-pending application provides three alternative preferred methods of mobility prediction for use in predicting future values of packet latency: deterministic, stochastic, and adaptive, with adaptive providing superior accuracy results.

Please amend the paragraphs beginning on page 18, line 19 to page 19, line 21, as follows:

Generally, the deterministic method is based on the recognition that a functional mapping relationship exists between signal strength S determined in the MAC portion of the physical network layer 2 programming of the mobile node, and packet latency τ identified in the mobile node's network layer programming. It is known that S varies as a function of distance d between the BTS and the mobile node. Thus, the deterministic approach provides a mathematical relationship between latency τ, distance d, and other system parameters such as transmitting power, channel bandwidth, antenna constants, additive white Gaussian noise (AWGN), etc. that can be used to predict future values of packet latency from the values of past samples. The deterministic

approach of the present invention provides the following two equations, which express the packet latency τ in a single path model and the packet latency $\bar{\tau}$ in a multipath model:

$$\tau \cong \frac{T_x P_t}{P_t - \beta d^i N_0 B} \qquad (1)$$

$$\bar{\tau} = \frac{M T_x P_t \bar{\alpha}^2}{M P_t \bar{\alpha}^2 - \beta d^i N_0 B} \qquad (2)$$

where T_x is the transmission time per packet, P_t is the transmission power, B is the receiver bandwidth, N_0 is the noise power spectral density, d^i is the distance between the mobile node and BTS_i, β is a constant related to the free space constant, $\bar{\alpha}^2$ is the squared average of a gain of the Rayleigh fading channel, and M is the multiplicity of the mult-path.

Equation (1) identifies the relationship between packet latency T and the distance d between the router and the mobile node in a free space, no faded environment. Equation (2) shows the same relationship in a mutipath fading environment. The derivation of these equations, as well as the meanings of the symbols used in the equations, is discussed in detail in the above co-pending application. The stochastic approach of the present invention provides a probabilistic estimation of future packet latency as a function of current and past packet latencies.

The stochastic method is generally based on the recognition that both L2 signal strength S and L3 packet latency τ are stochastic processes, S(t) and r(t) respectively, where t is time. Thus, a conventional least mean squares (LMS) approach can be used to predict future L3 packet latency values from the values of past packet latency samples. Under the stochastic

approach of the present invention, a future value $\tau_{predicted}(t_{n+1})$ of packet latency τ is statistically predicted based on values $\tau(t_n), \tau(t_{n-1}), \tau(t_{n-2})$ of past packet latency. That is:

$$\tau_{predicted}(t_{n+1}) \approx E[\tau(t_{n+1}) \mid \tau(t_n), \tau(t_{n-1}), \tau(t_{n-2})] \quad `(3)$$

In Equation (3), three values of past packet latency are used for convenience of calculation. But it should be appreciated that the number of values of past packet latency used is not limited to 3. Equation (3) can be solved by the following algorithm:

$$\hat{\tau} = K_0 \underline{\tau_{t_N}} \quad (4)$$

where, $\underline{\tau_{t_N}} = \begin{bmatrix} \tau(t_n) \\ \tau(t_{n-1}) \\ \tau(t_{n-2}) \end{bmatrix}$ and $K_0 = [k_n \quad k_{n-1} \quad k_{n-2}]$

Please amend the paragraphs on page 20, lines 3-8, as follows:

The following three models are available for the adaptive prediction method:

$$\hat{\tau}_{adaptive} = \omega_0 \tau_D(d_{est} + \Delta d) + \omega_1 \tau(t_n) + \omega_2 \tau(t_{n-1}) \quad (5)$$

$$\hat{\tau}_{adaptive} = \omega_0 \tau(t_n) + \omega_1 \tau(t_{n-1}) + \omega_2 \tau(t_{n-2}) \quad (6)$$

$$\hat{\tau}_{adaptive} = \tau(t_n) + \omega_0 \Delta_0 + \omega_1 \Delta_1 \quad (7)$$

where $\tau_D = f(d)$, <u>$f(.)$ being any function that relates the distance d between the mobile unit and the BTS,</u> $d_{est} = f^{-1}(\tau)$, $\Delta d = d_m - d_{m-1}$, <u>d_m being the incremental distance between estimates,</u> and ω_0, ω_1 and ω_2 are weight coefficients. Also,

$\Delta_0 = t_n - t_{n-1}$ and $\Delta_t = t_{n-1} - t_{n-2}$.

Please amend the paragraph on page 22, lines 6-17, as follows:

In a Mobile IP version 6 network, the pre-registration process 720 is similar to that in a Mobile IP version 4 network. However, additional functionality is provided in Mobile IP version 6 that may be desirable to use. Thus, it may be desirable in addition for the mobile node 135 to send an <u>Internet Control Message Protocol (</u>ICMP<u>)</u> HA Address Discovery Request to its home router any cast address, as specified in the Mobile IP version 6 document, to determine if its home router IP address configuration has changed before beginning the pre-registration process 720. Also, in Mobile IP version 6 networks, the mobile node 135 may set the new router IP address as an alternate "care of" address in the packet routing header (See Fig. 6) that accompanies all packets before pre-registering, and then later switch the alternate "care-of" address to be its primary "care-of address once a new route is established between the mobile node 135 and the correspondent node 140.